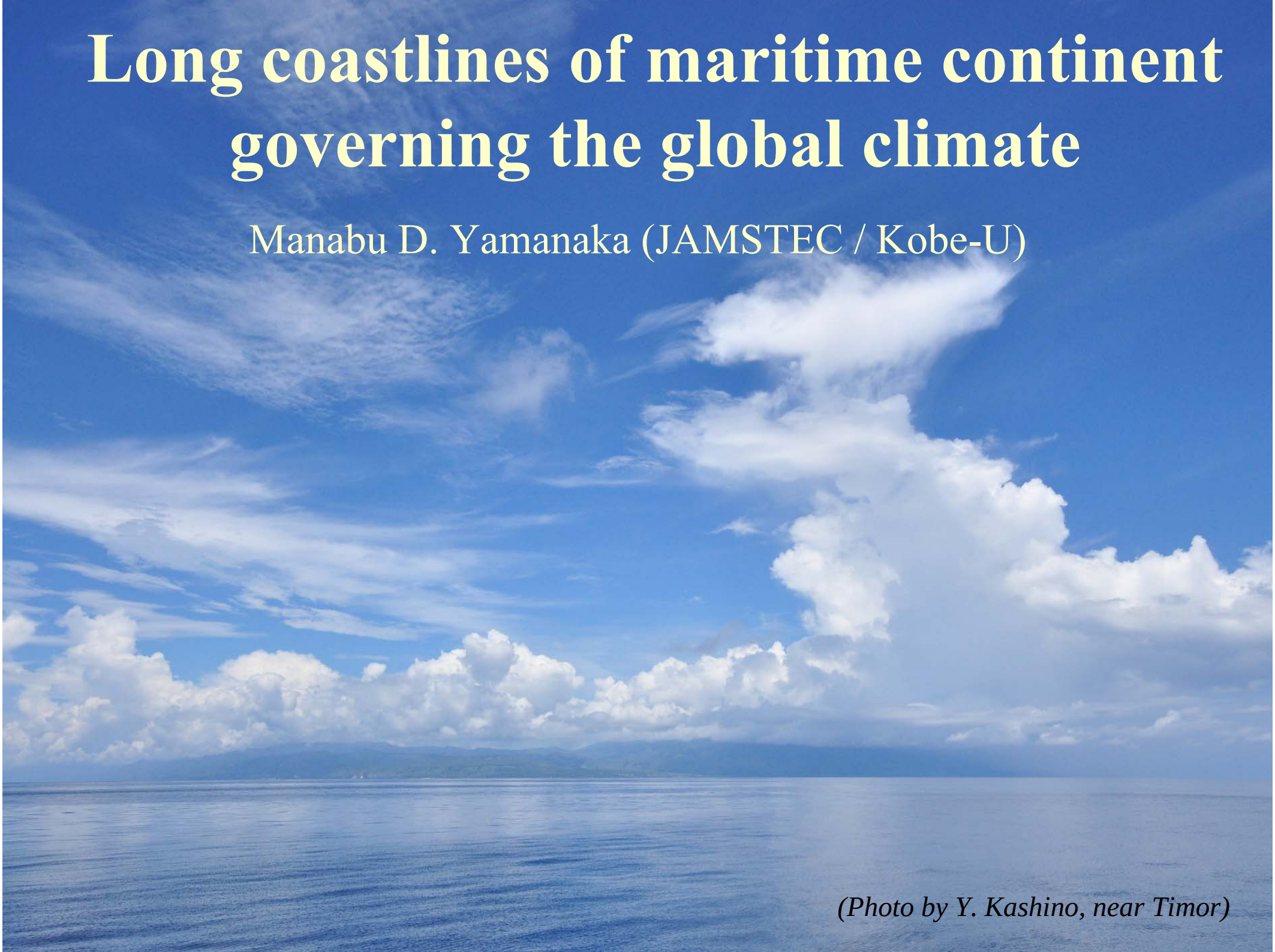
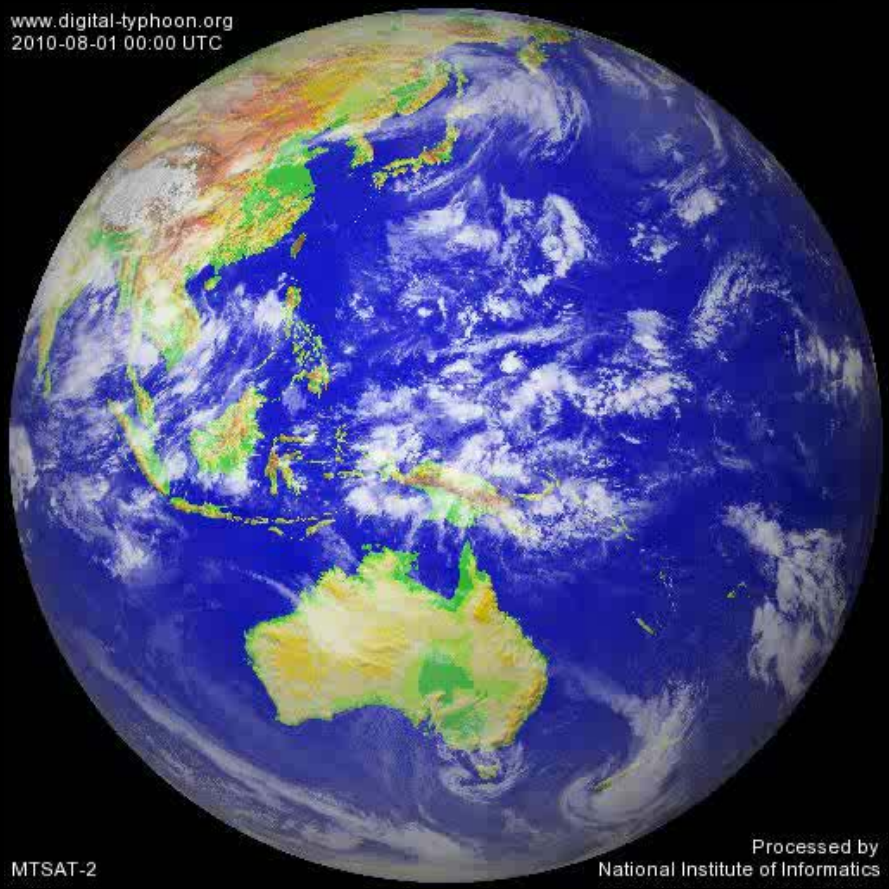
# Long coastlines of maritime continent governing the global climate

Manabu D. Yamanaka (JAMSTEC / Kobe-U)

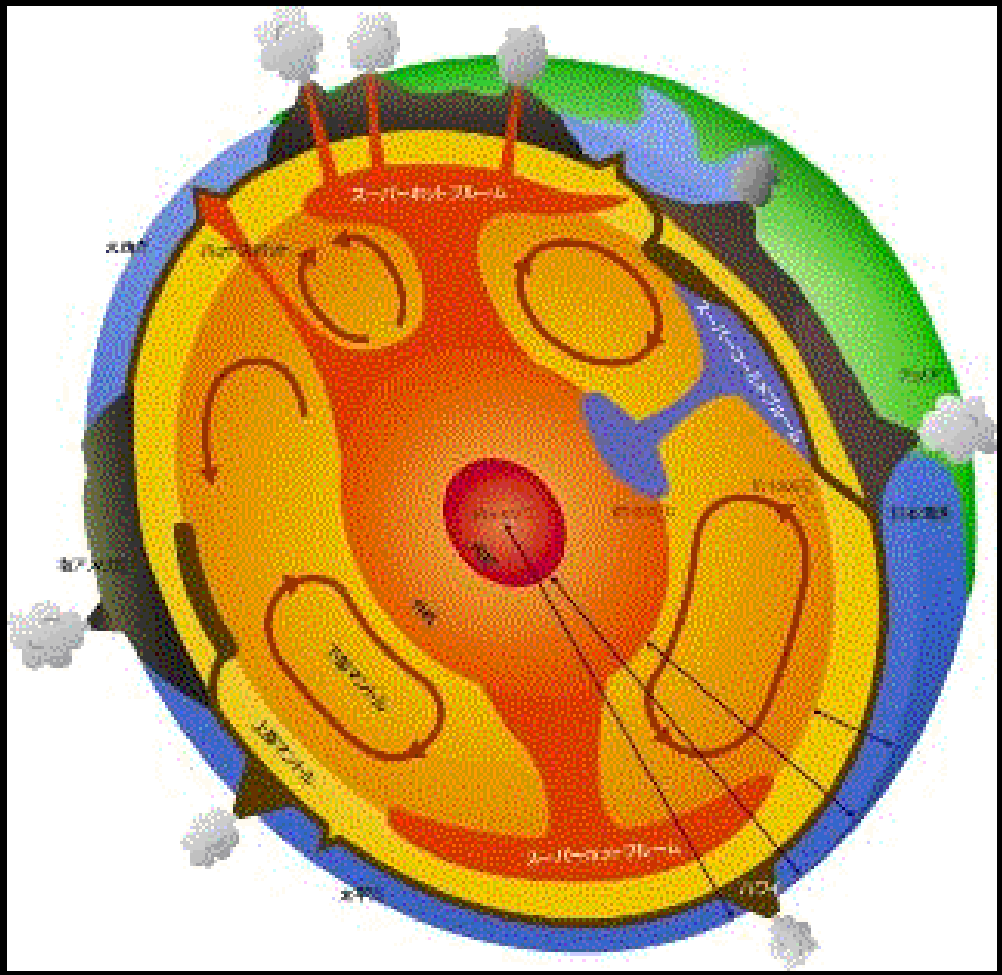


*(Photo by Y. Kashino, near Timor)*

# Convection ↔ Uneven earth

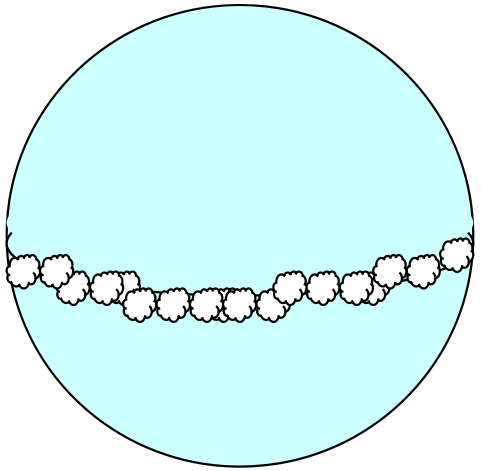



MTSAT-IR (August 2010）



(by IFREE/JAMSTEC)

# Equatorial Cloud & Precipitation in Global Climate



?

**2000 mm/year**

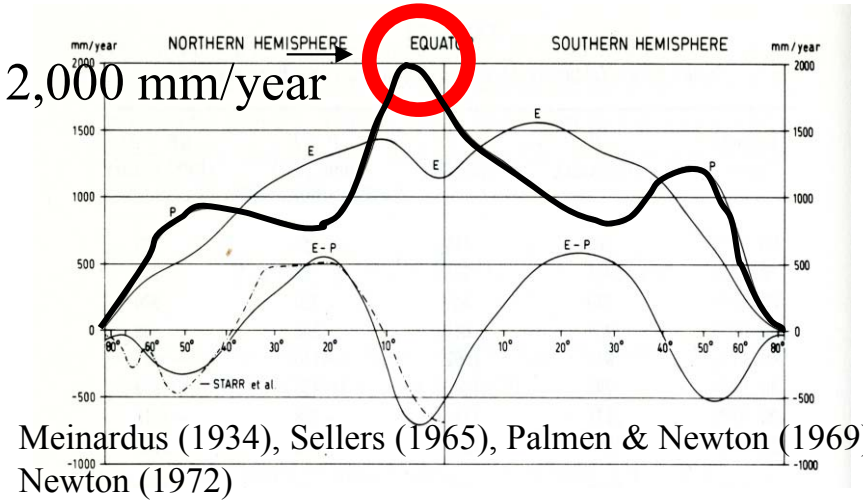
≒ 5.5 mm/day
if rainfall every day and everywhere

or

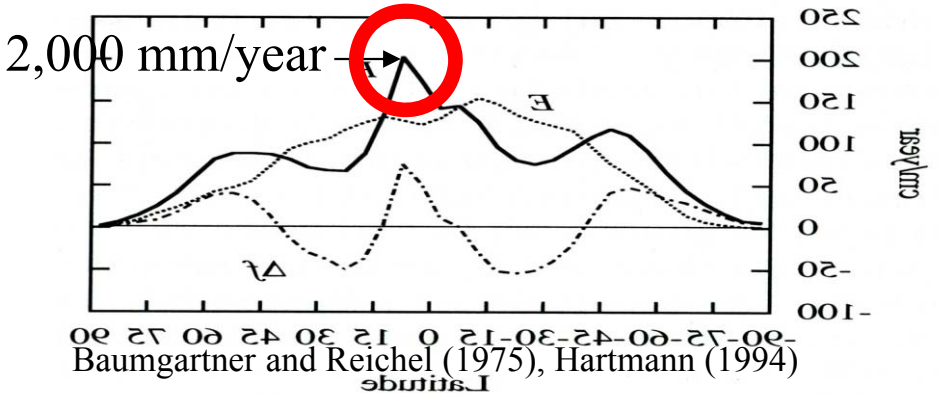
11 mm/day
if 180 rainy days/year everywhere
or every day over a half area

or

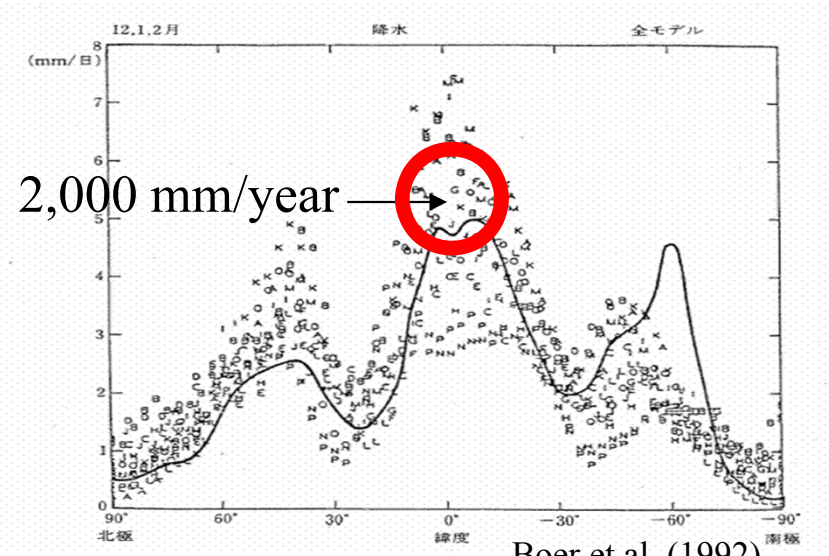
.....




Meinardus (1934), Sellers (1965), Palmen & Newton (1969)
Newton (1972)

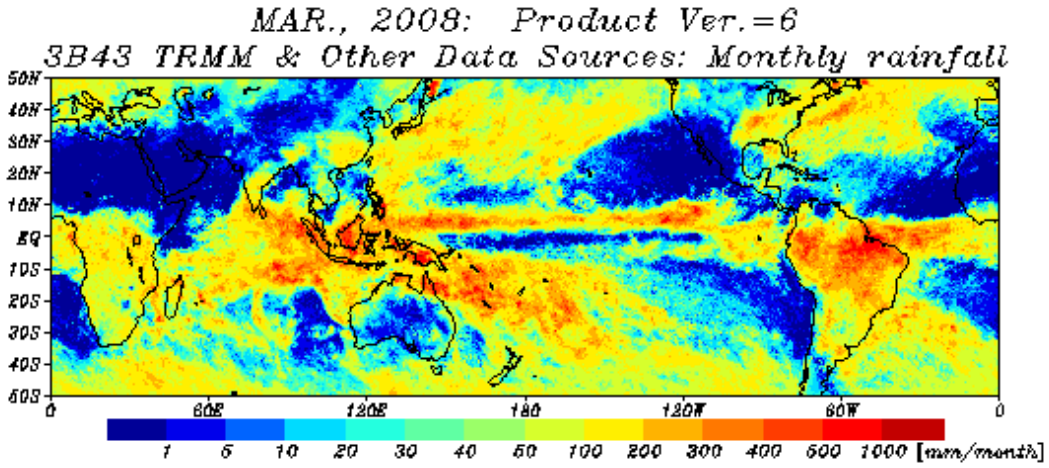


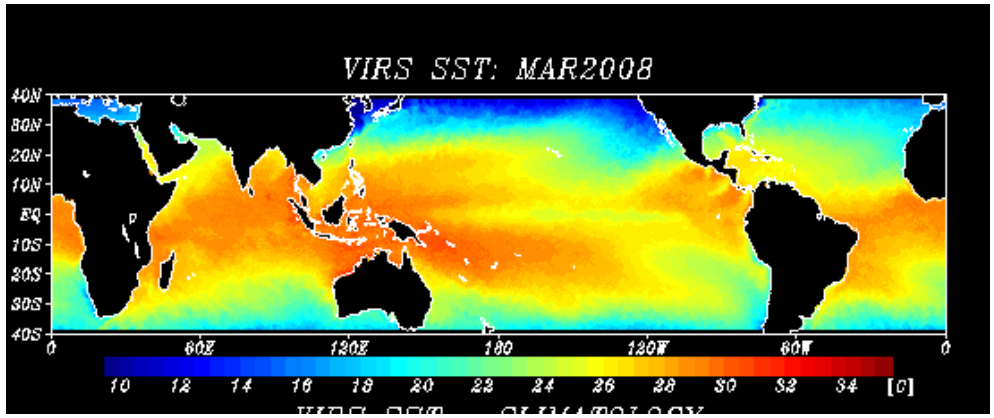

Baumgartner and Reichel (1975), Hartmann (1994)




Boer et al. (1992)

# “Conditional Instability” paradox



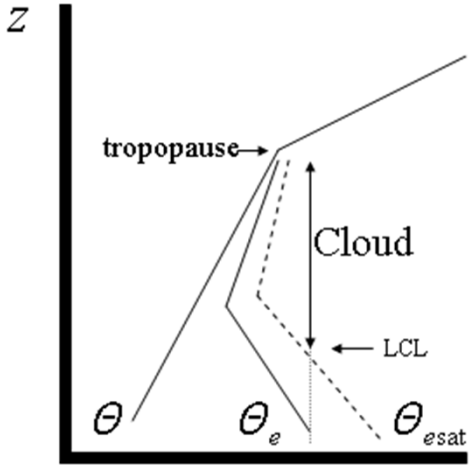

Indonesian maritime continent:
- The most active convective clouds
- The largest rainfall

Why ?

Surrounded by “warm water pool”?

If so, why large rainfall does not appear over ocean but over land ?

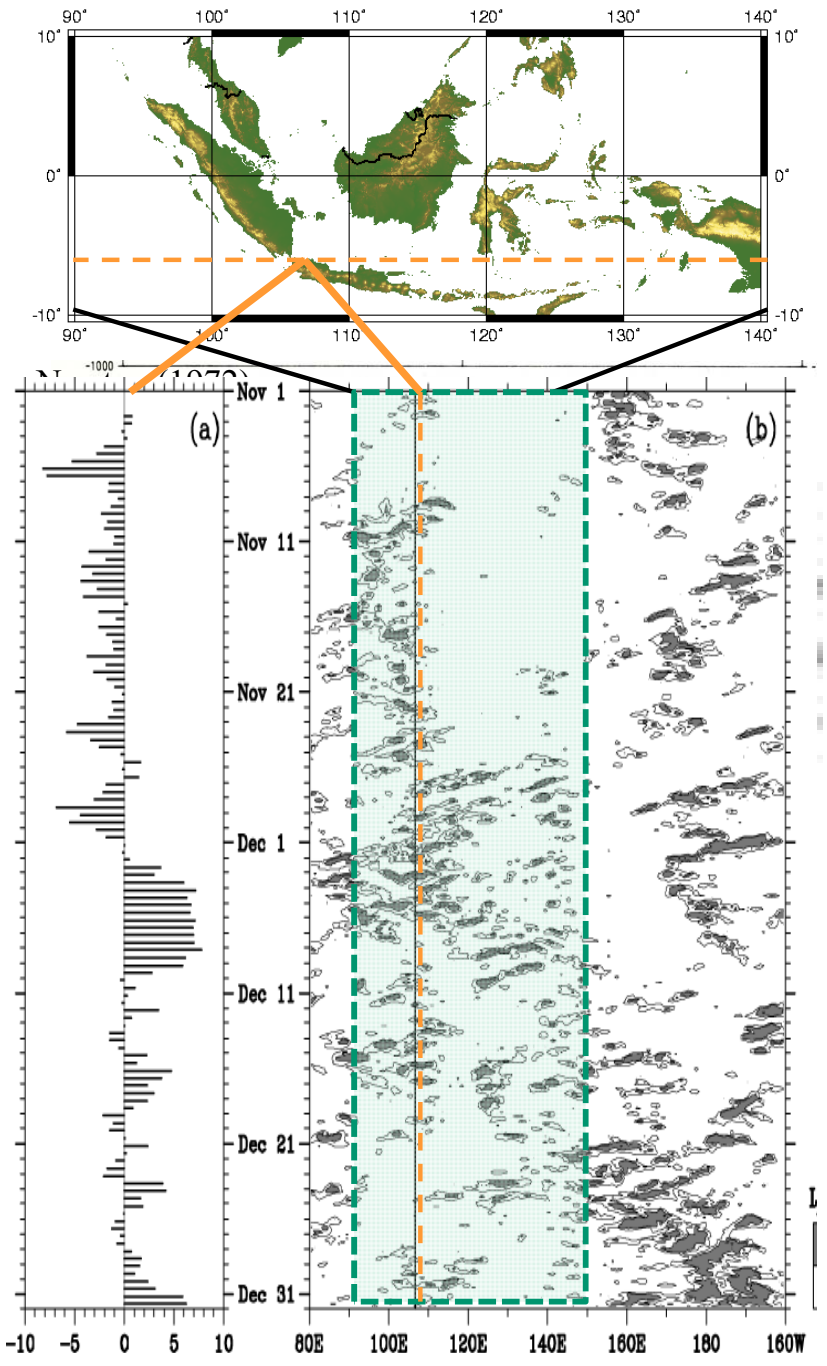
Land with smaller specific heat generates convection much easily?



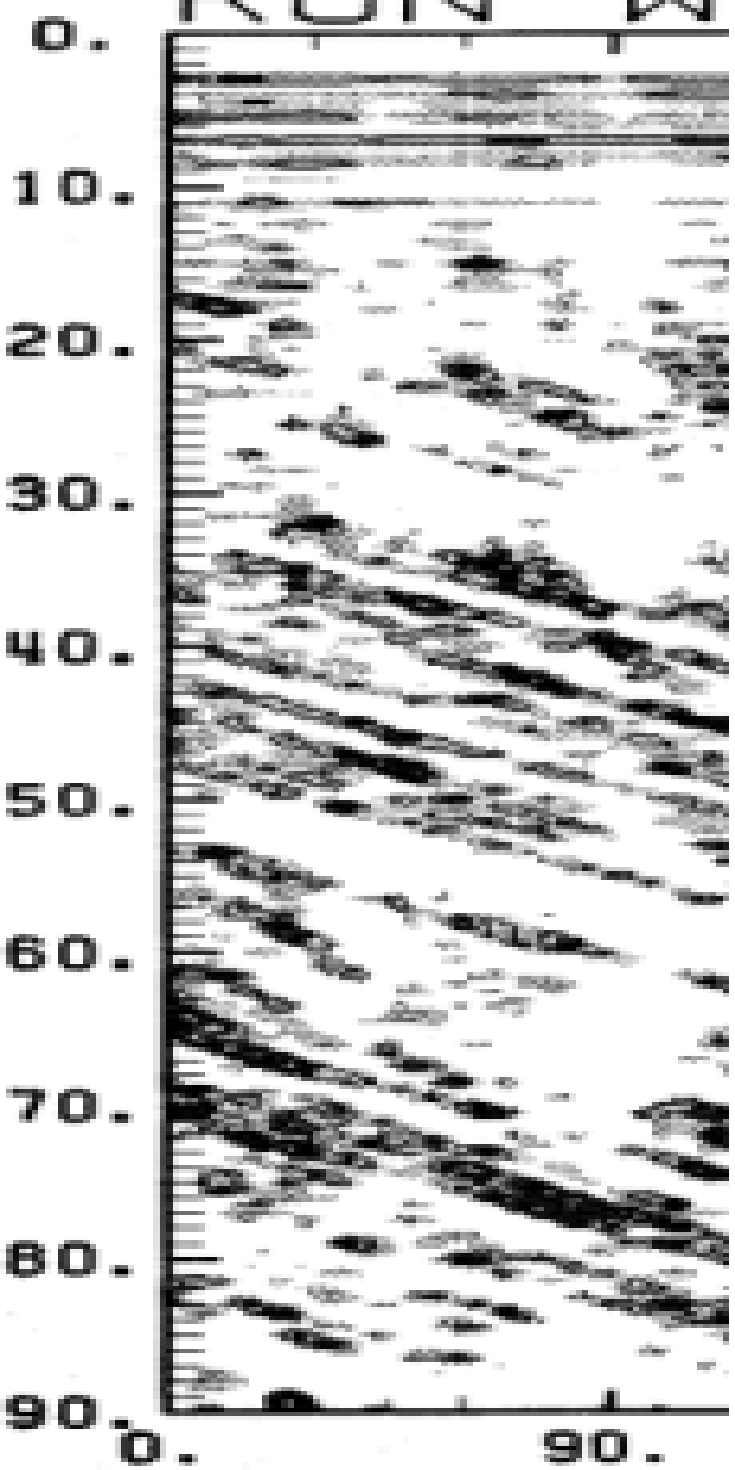

Again, why not Africa nor S. America but maritime continent ?

**Conditional instability**:
- Convection generated spontaneously only when cloud appears.
- Cloud becomes most active when convection is developed.

⇒ *Forced motions (waves, circulations), or CISK*



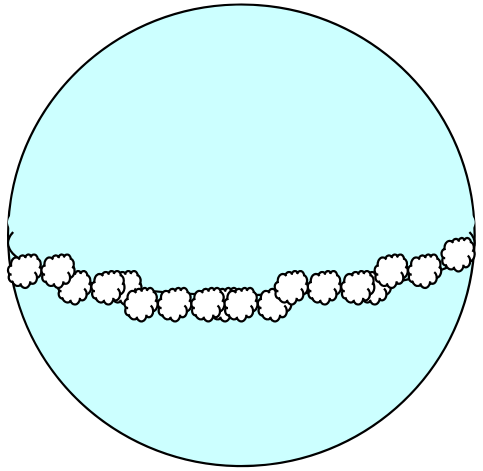

Hashiguchi et al. (1995)

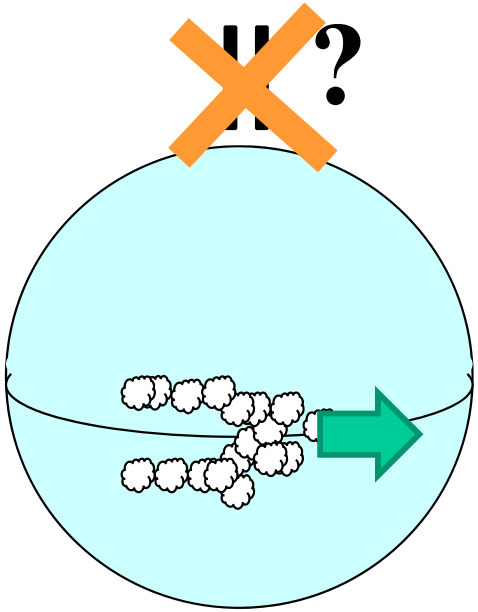



Hayashi & Sumi (1985)

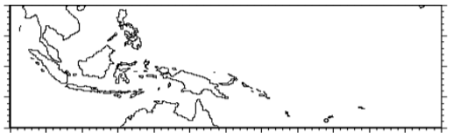
Harimau

# “Aqua Planet” → ISVs



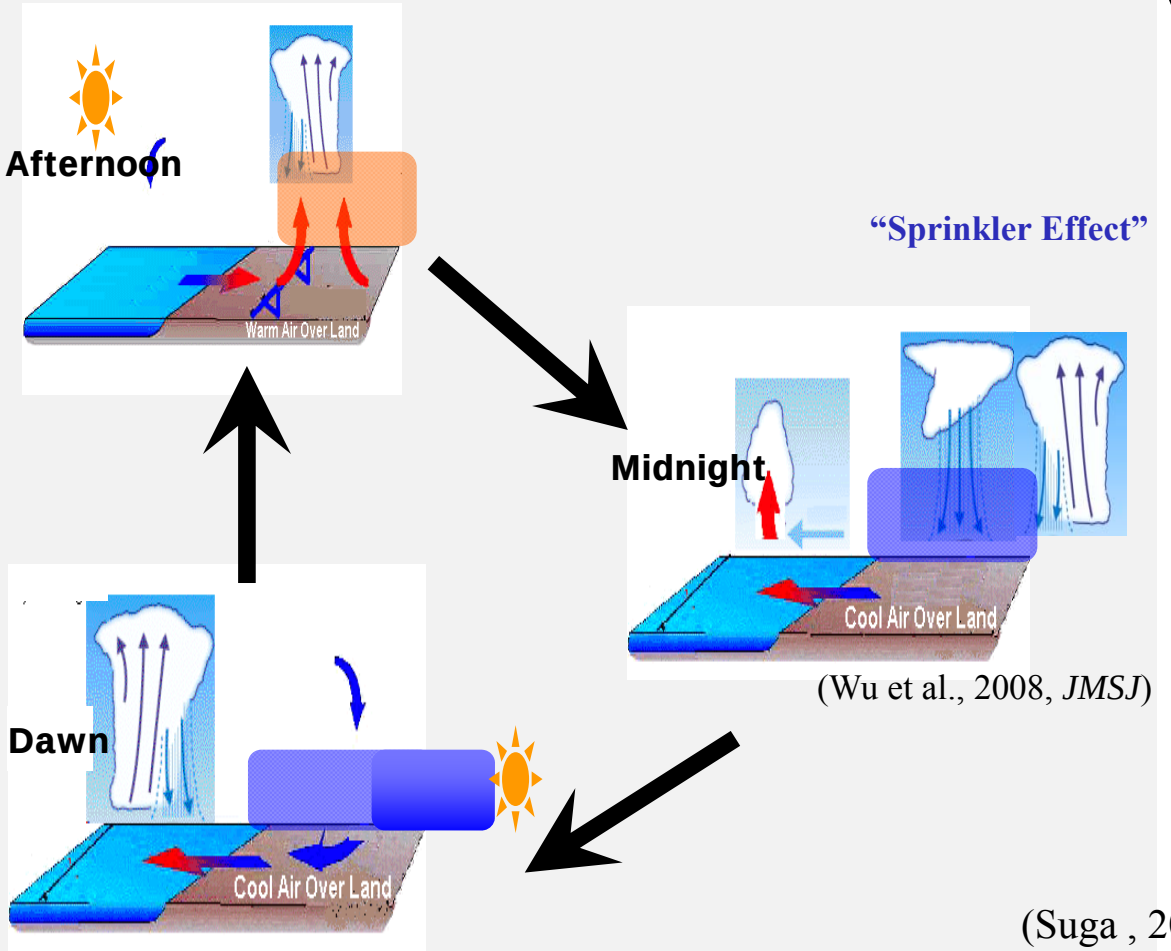


# Spectral distribution of GMS cloud height

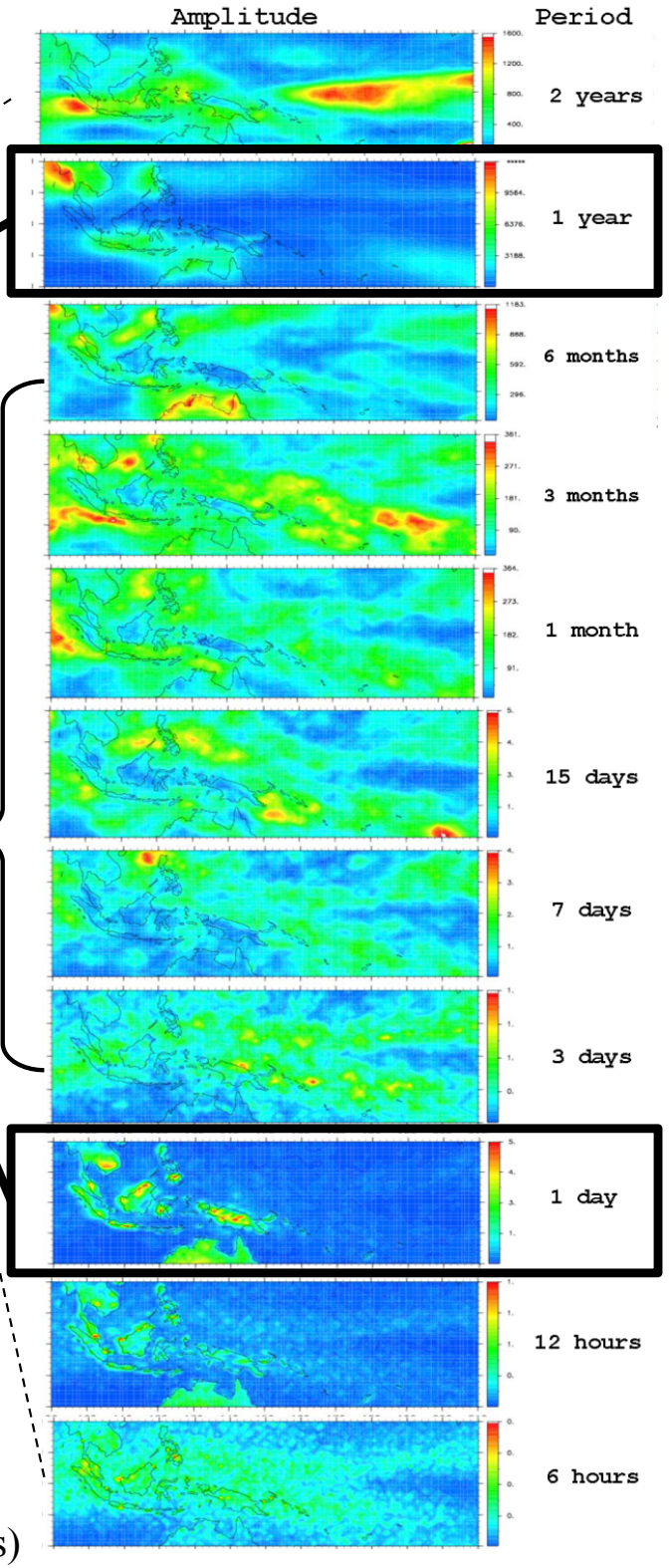


Interannual, intraseasonal
& subdiurnal variations
over oceans

**Annual & Diurnal cycles around lands**




(Wu et al., 2008, *JMSJ*)

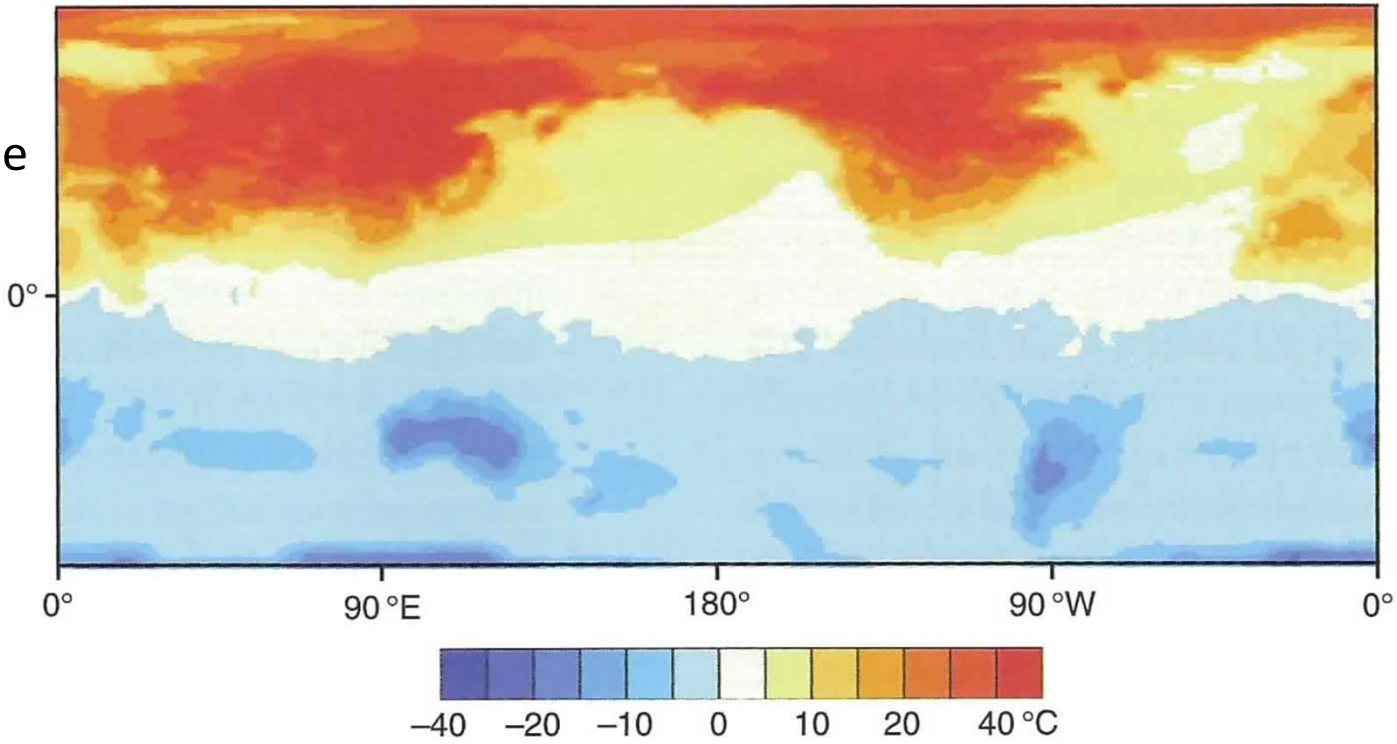



(Suga , 2010, MS thesis)

# Seasonal/diurnal cycles by land-sea contrast

"Find the continents" game
July – January

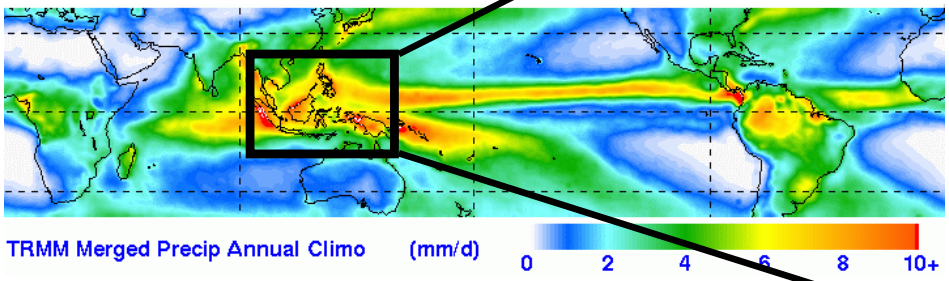
(Wallace & Hobbs, 2006;
original by Mitchel)

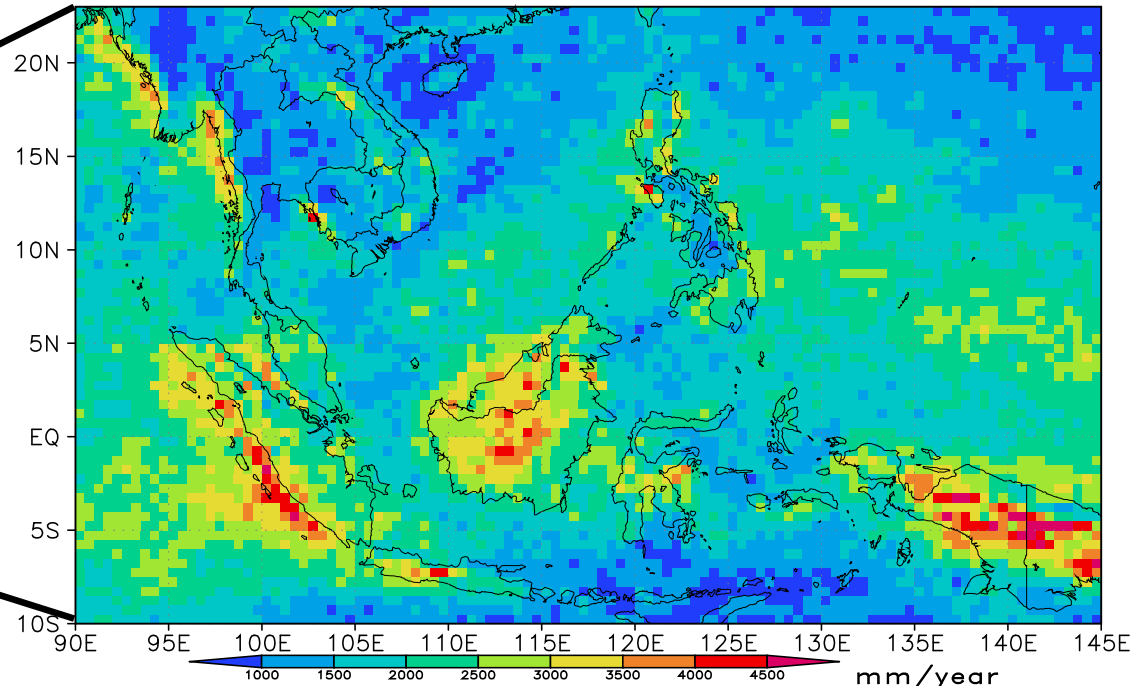



"Find IMC" game
Monthly-mean
hourly cloud height

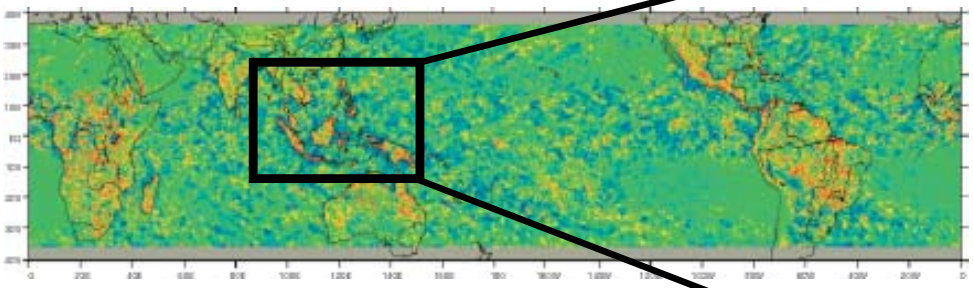
(Suga , 2010, MS thesis;
cf. Mori et al., 2004)

# Equatorial rainfall
# Diurnal → Coastal

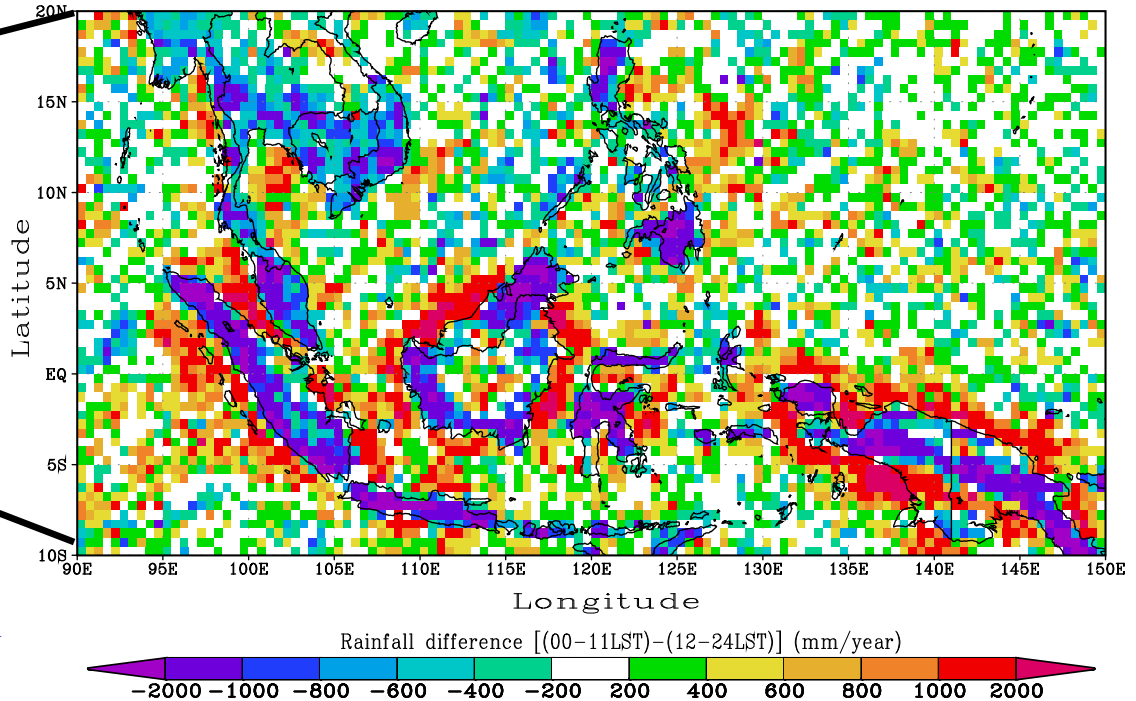



Correlation between **annual rainfall** and **diurnal cycle** dominancy of rainfall



(Hirose & Nakamura, 2004, *J. Appl. Meteor.*)

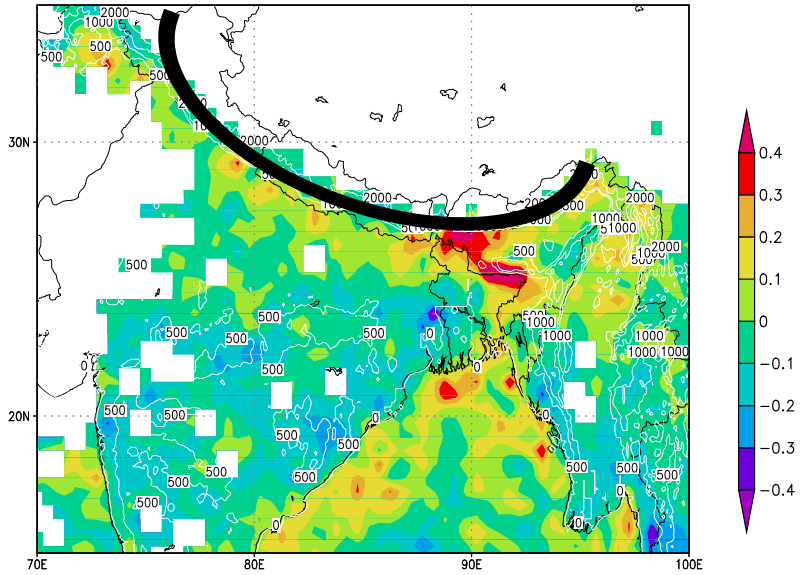


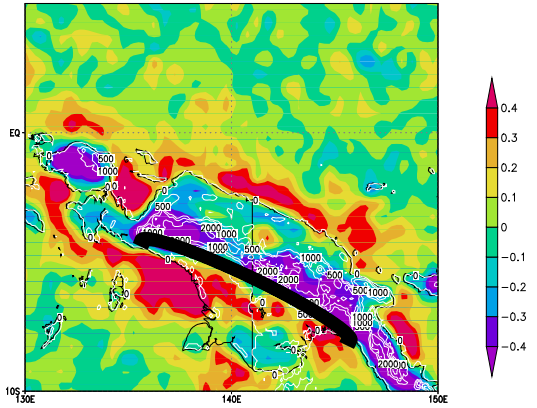

**Morning Rain** — **Evening Rain**

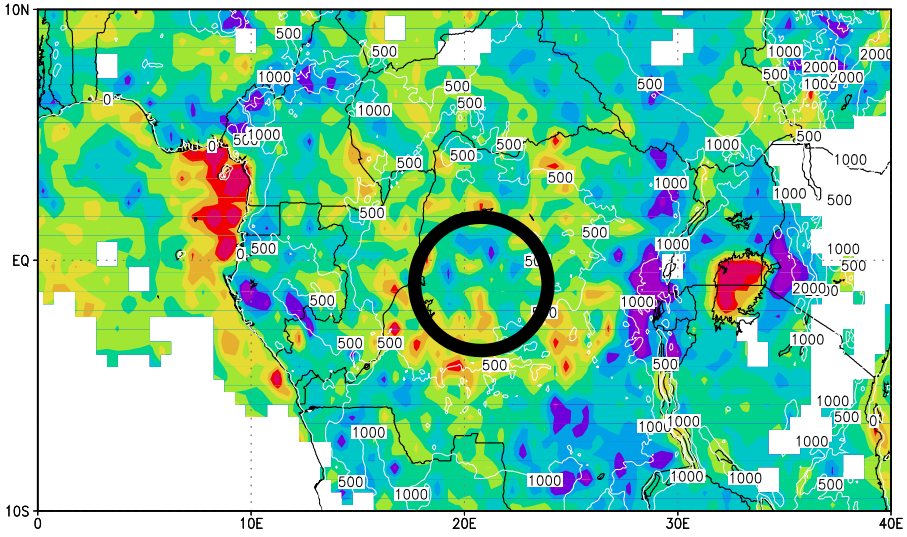
(Mori et al., 2004, *Mon. Wea. Rev.*)

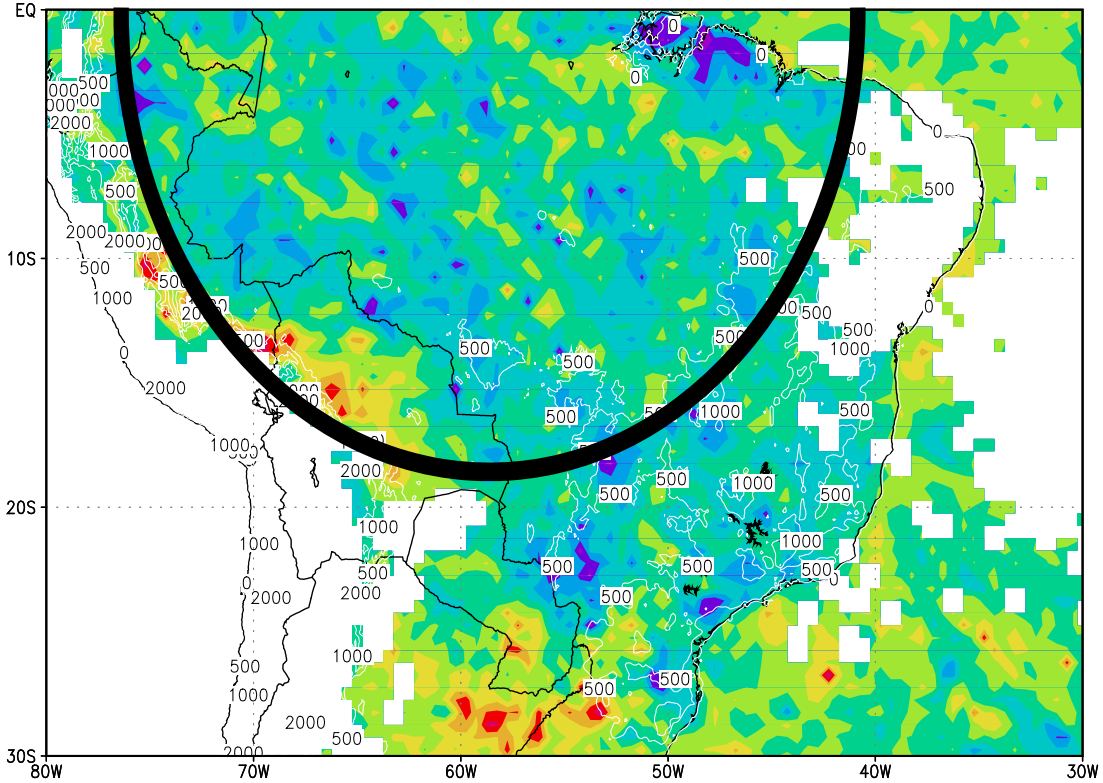
Harimau

# Mountain-valley-breeze-like morning rain & night rain



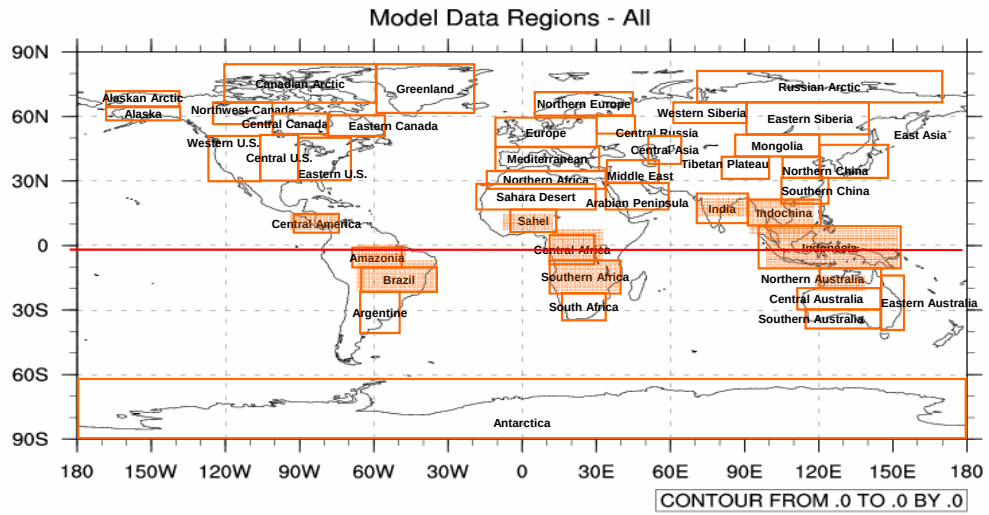

(Mori, 2007, private communication)

Harimau

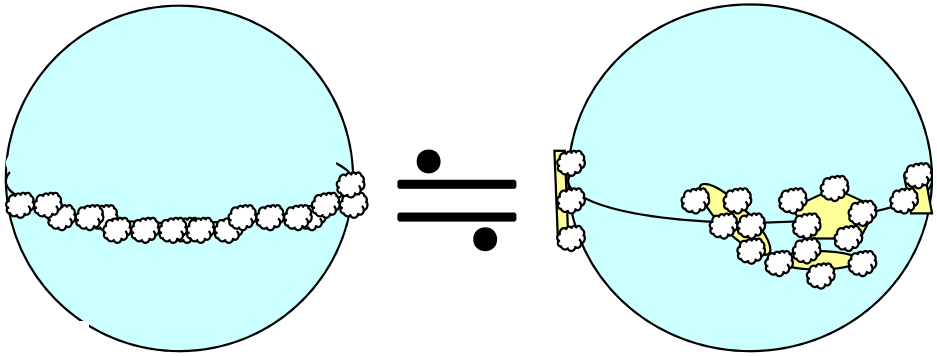
# Coastline length & mean rainfall in 10 tropical areas

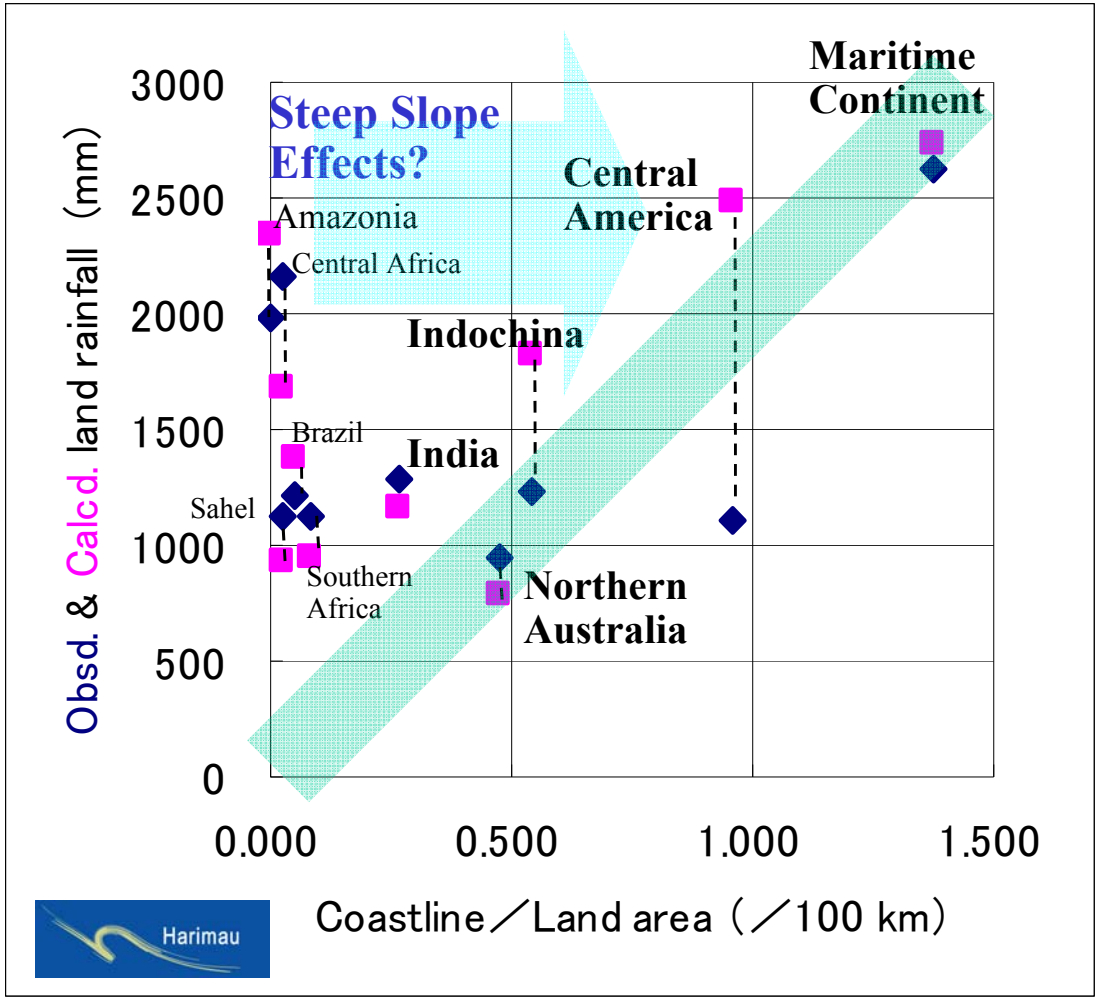
| Area | Latitude (deg N) | Longitude (deg E) | Land area ($10^4$ km$^2$) | Coastline ($10^2$ km) | Obs.rain (mm/year) | Calcd.rain (mm/year) |
|---|---|---|---|---|---|---|
| India | 10 – 24 | 71 – 91 | 144.5 | 39 | 1,289 | 1,158 |
| Indochina | 9 – 21 | 91 – 121 | 145.0 | 79 | 1,237 | 1,816 |
| Sahel | 6 – 16 | –5 – 13 | 180.0 | 5 | 1,132 | 921 |
| Central America | 6 – 15 | –93 – –74 | 47.5 | 46 | 1,105 | 2,474 |
| Central Africa | –9 – –4 | 11 – 29 | 227.0 | 6 | 2,158 | 1,684 |
| **Indonesia** | –10 – 9 | 96 – 153 | 242.5 | 333 | 2,632 | 2,737 |
| Amazonia | –10 – –1 | –69 – –49 | 180.0 | 0 | 1,974 | 2,342 |
| Southern Africa | –23 – –7 | 11 – 40 | 410.5 | 33 | 1,132 | 947 |
| Northern Australia | –20 – –10 | 120 – 145 | 136.5 | 65 | 947 | 789 |
| Brazil | –22 – –10 | –65 – –34 | 311.5 | 15 | 1,211 | 1,382 |

More than 80 % of earth's circumference (400 00 km)




43 regions for local climate examination using 600-year (1870-2450) run of NCAR-CCSM3 on Earth Simulator. (Maruyama et al., 2000; Yoshida et al., 2005)

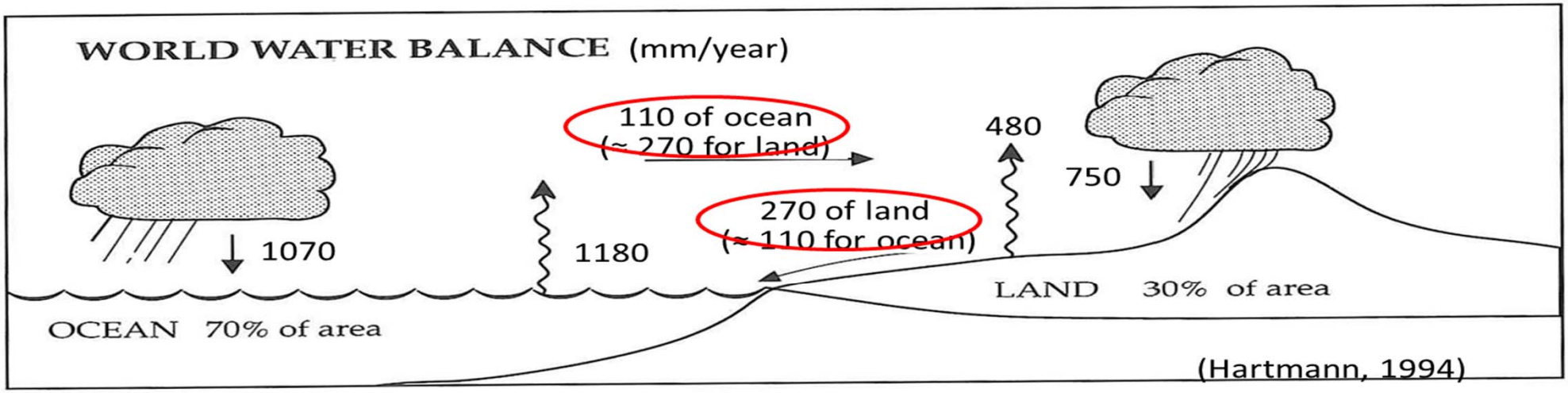




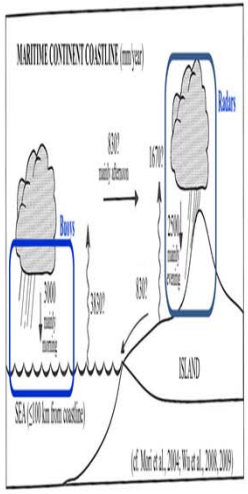

Regional (land) rainfall (mm/year) ＝2000 (mm/year•$10^2$ km) ×[Coastline ($10^2$ km)/Land area ($10^4$km$^2$)

→ Total rain water amount on land (Gt/year) ＝2000 (mm/year•$10^2$ km) ×Coastline ($10^2$ km)

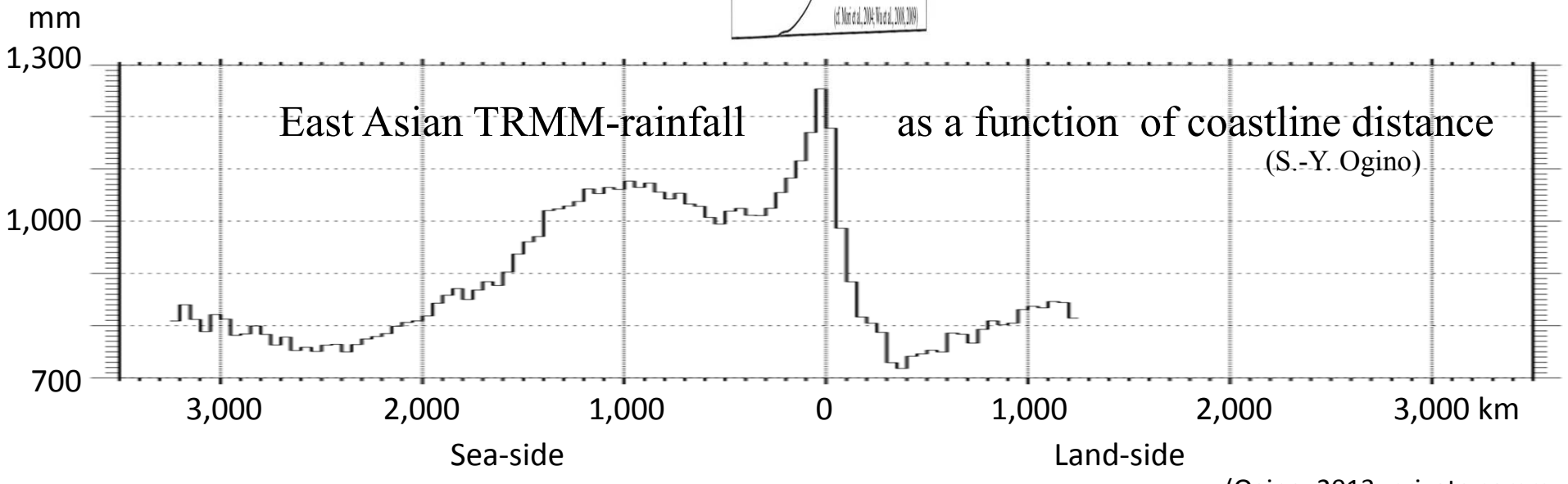
- **The maritime continent with the longest coastlines has the largest rainfall.**
- Numerical models must resolve coastlines with 100 km or higher resolution.
- Radar-AMeDAS-like observations must cover all the coastlines/mountain slopes.




**Water cycle concentrated**

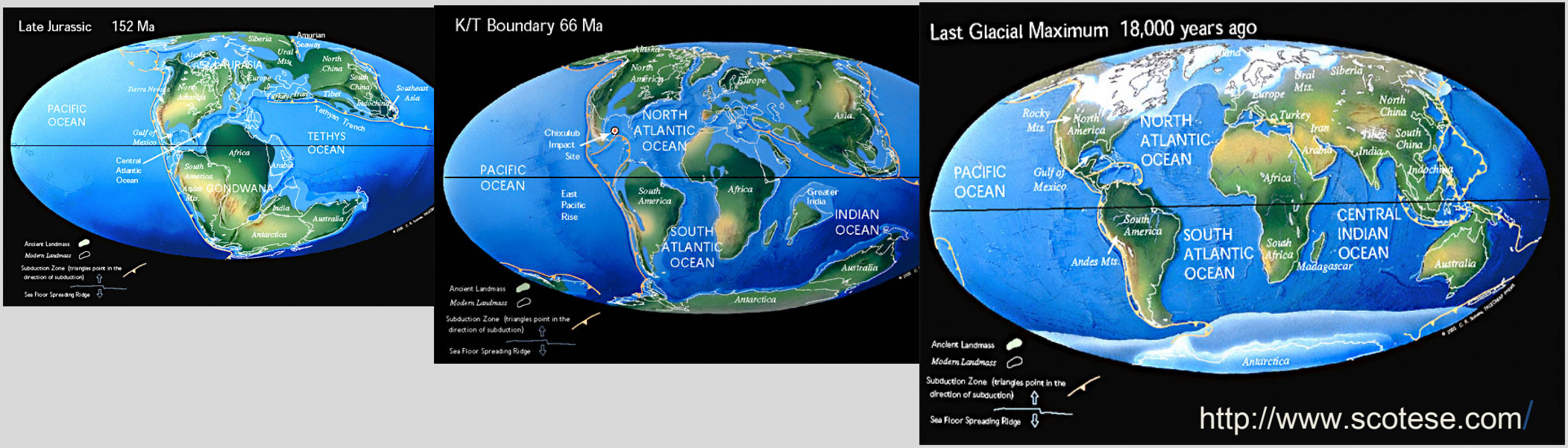


**along tropical coastline**



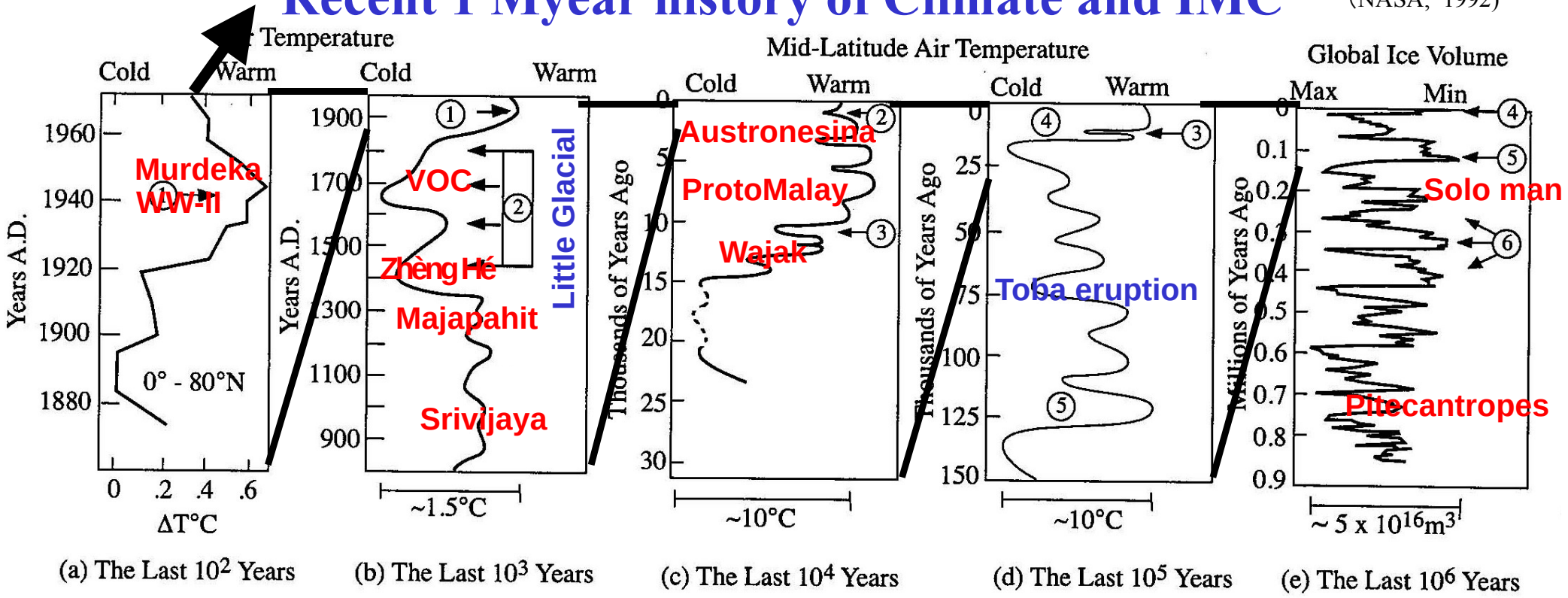

(Ogino, 2013, private communication)

# Ocean: Continent ~ 7: 3 concerved for 400 MYears



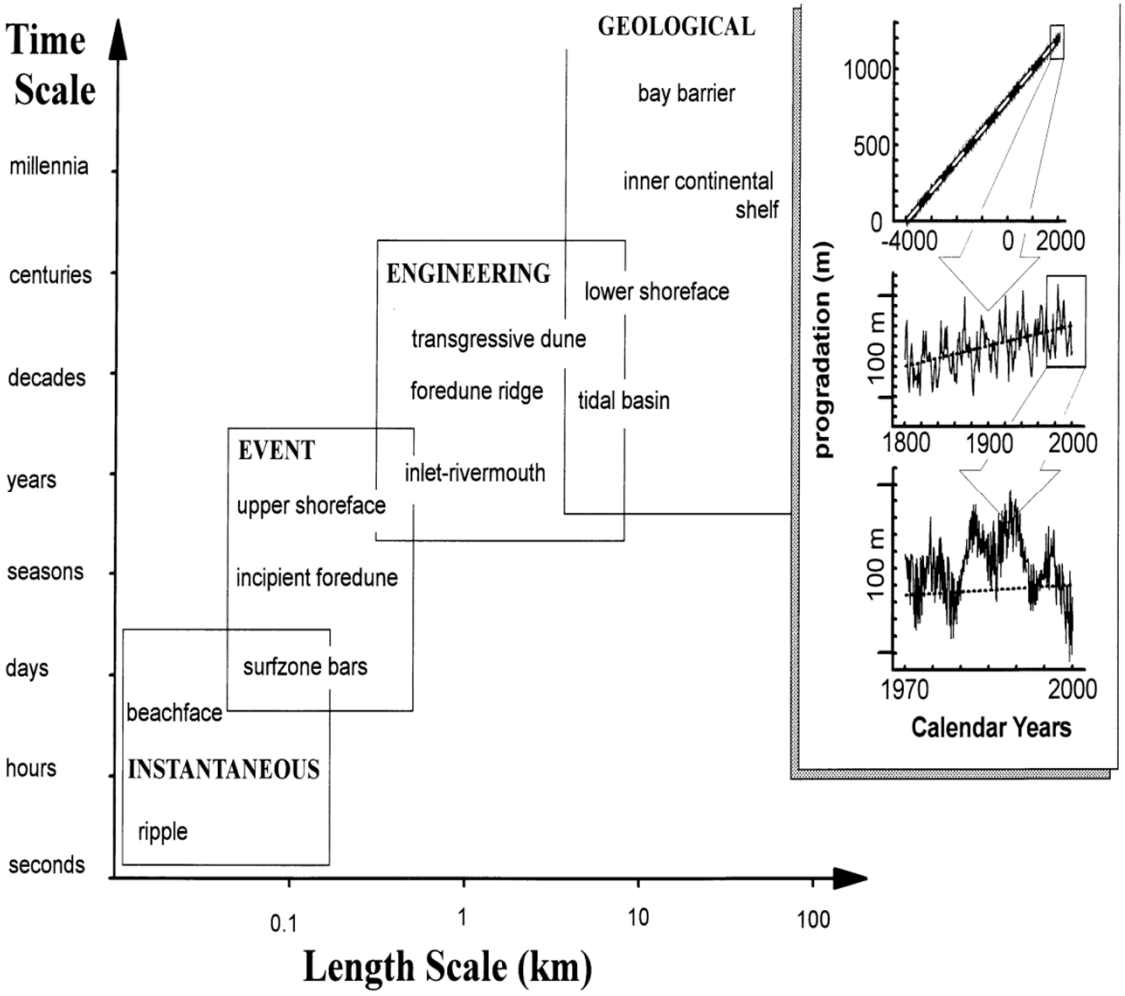

# Recent 1 Myear history of Climate and IMC

(NASA, 1992)



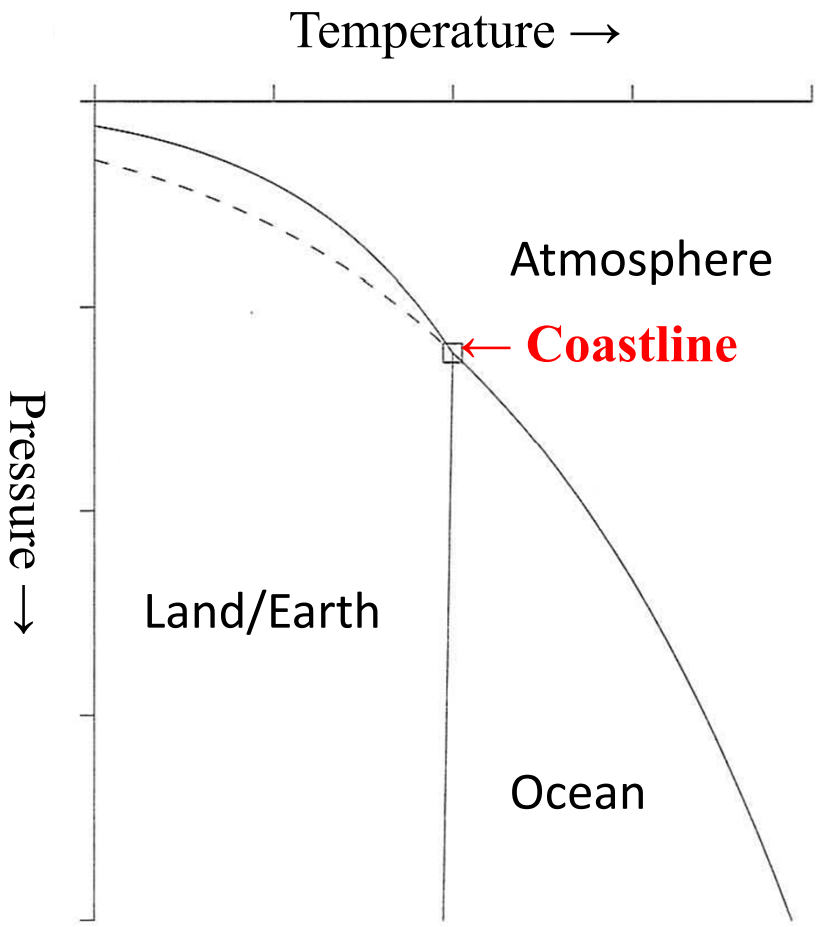
# Coastline: Land-Sea-Atmosphere boundary

## Erosion-Orogeny balance

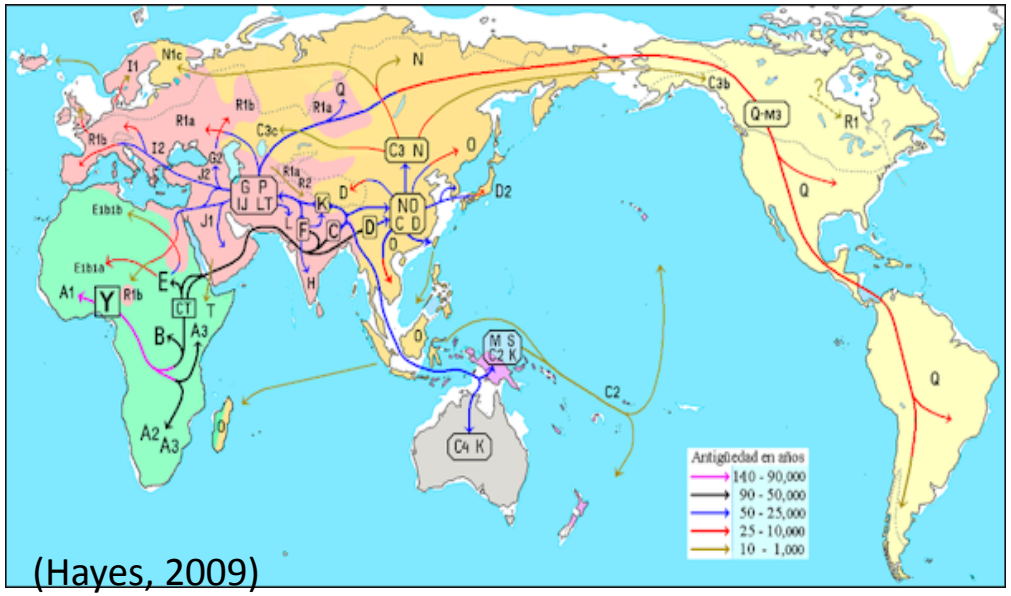



(Thom & Cowell, 2005, in *Encyclopedia of World climatology*, *Encyclopedia of Coastal Science*)

## "Multiple-point" analogy

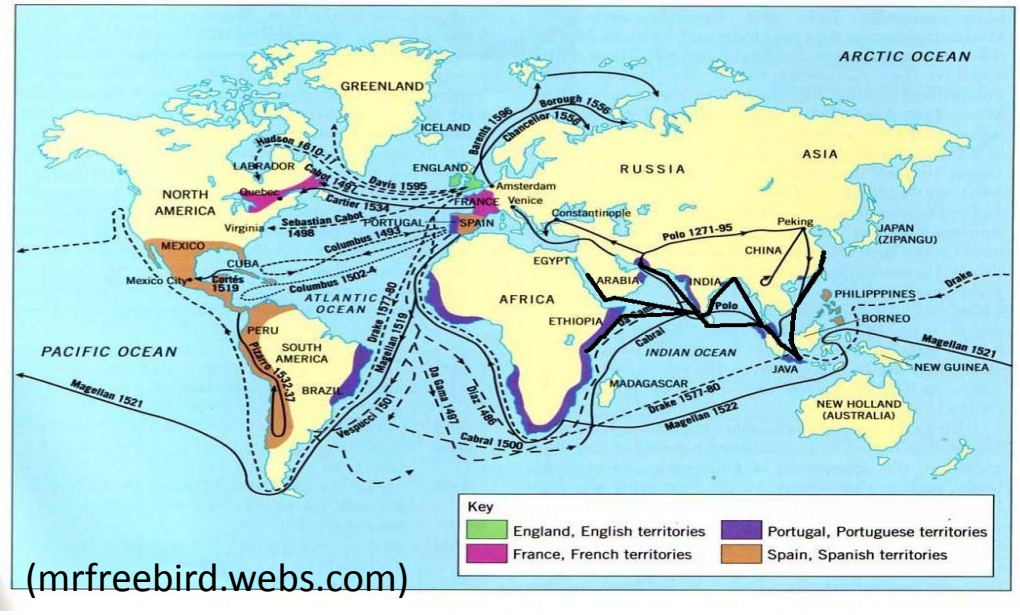


# Homo Sapiens' "Great Journey"

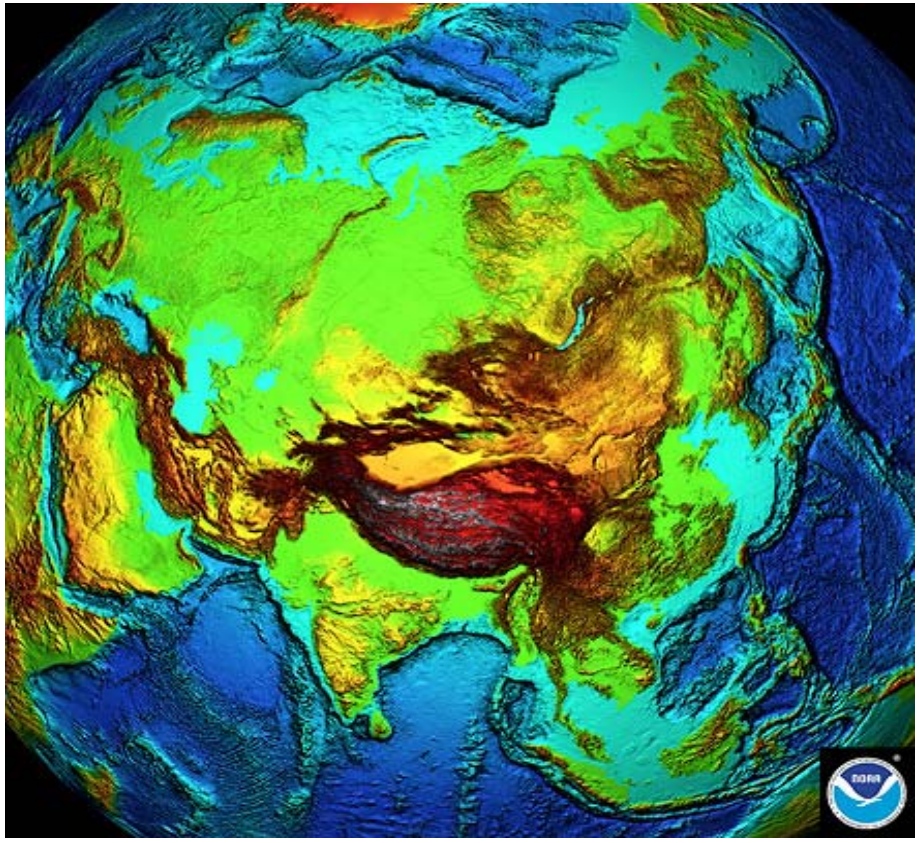



(Hayes, 2009)

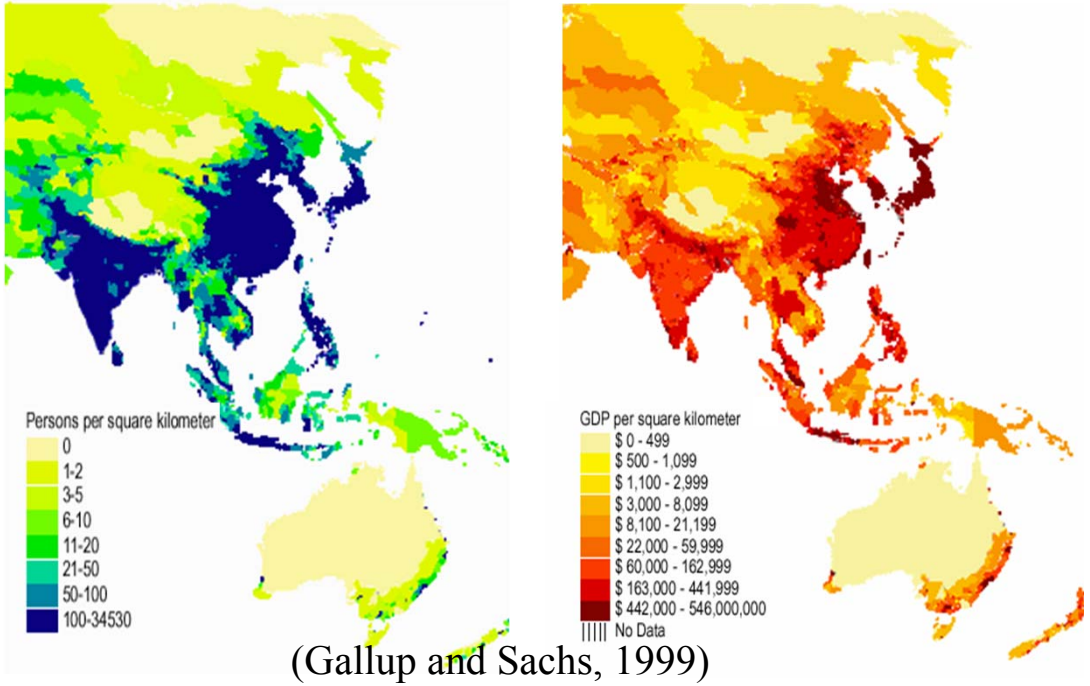
# "Great Voyages"




(mrfreebird.webs.com)



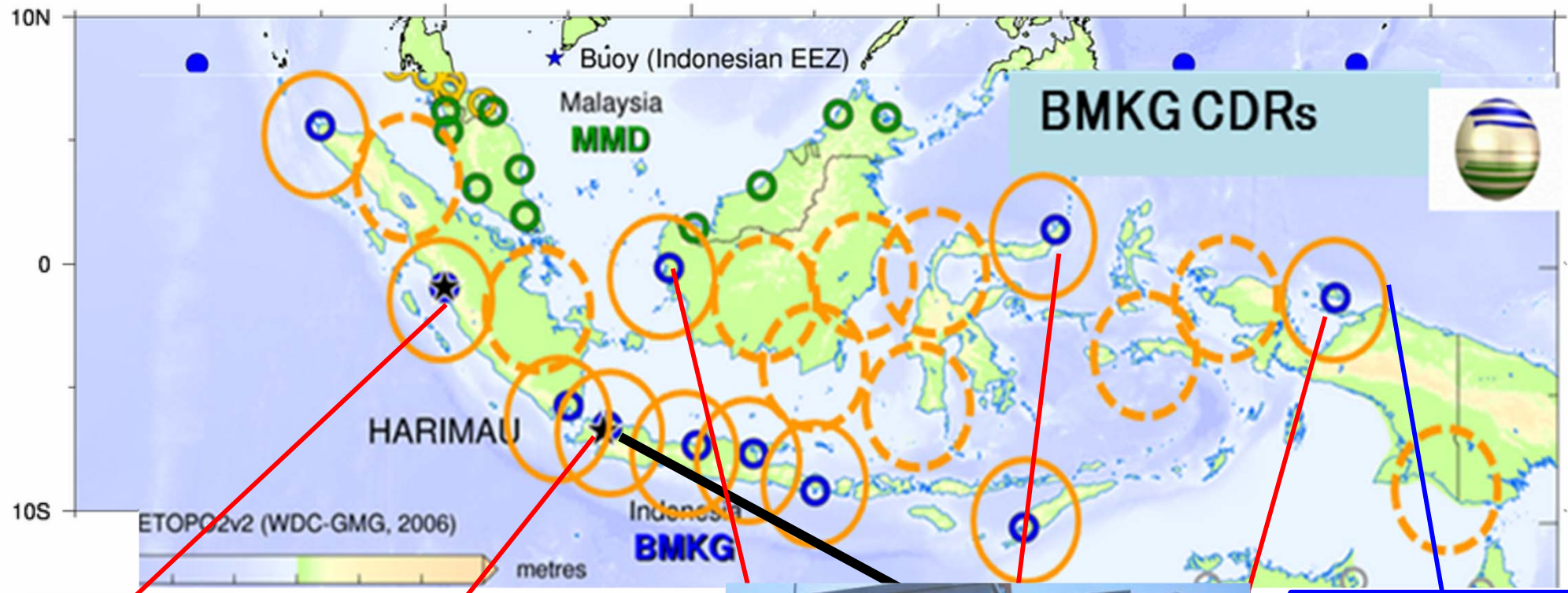
# Population &GDP at present




(Gallup and Sachs, 1999)

JEPP-HARIMAU (FY2005-09)

SATREPS-MCCOE Buoy/Radar Network (FY2009-13)

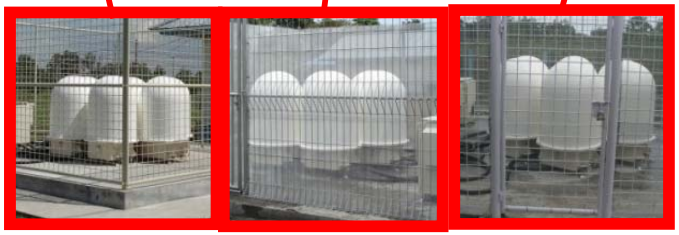



MIA XDR

Serpong CDR


Transportable MPR

**Maritime Continent COE (MCCOE)**



Pontianak/Manado/Biak WPRs

InaTRITON Buoy